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ECONOMIC REFORMS AND PRODUCTIVITY GROWTH IN INDIAN MANUFACTURING SECTOR – AN INTER STATE ANALYSIS

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ABSTRACT

The present paper endeavors to analyze the TFP growth trends in Indian manufacturing sector at both aggregated and disaggregated inter-state levels. Using the Malmquist productivity index for panel dataset of 16 major industrial state over a period of 29 years spanning over 1979-80 to 2007-08, the study observed manufacturing sector of India is growing with 9.1 percent per annum growth of Total Factor Productivity (TFP) during the entire study period. Out of Sixteen Industrial states there are five states namely Uttar Pradesh, Madhya Pradesh, Gujarat, Orissa and Rajasthan where double digit TFP growth has been noticed. The manufacturing sector of Uttar Pradesh is growing with highest TFP growth at the rate of 12.8 percent per annum followed by Madhya Pradesh with TFP growth of 11.8 percent per annum. The analysis of the sources of the TFP growth in Indian manufacturing sector reveals that both technical progress and technical change are equally contributing TFP growth in sector under evaluation. It has also been observed that at all India level efficiency change is greater than technical progress.

Key Words: Productivity, Manufacturing Sector, MPI

In India major economic reforms has been undertaken since July, 1991 with the objective of increasing productivity and competitiveness of the Indian manufacturing sector. The economic reformed process heralded the liberalisation of Indian industrial sector from various controls and regulations. This also implied a movement towards the establishment of a competitive market system with optimum resource utilisation. Under this process the firms were exposed to international competition which forced them to introduce new methods of production, import quality inputs along with modern technology to improve their efficiency. In this era, productivity growth is recognised as a key feature of economic dynamism. The industrial growth driven mainly by input growth is inevitably subject to diminishing returns to scale and may not be sustainable in the long run. Therefore, the policy makers are now pursuing the industrial growth through improvement and productivity driven strategies that lay emphasis on enhancing total factor productivity growth rather that investment driven growth.

In this paper, an attempt has been made to analyze the impact of economic reform process on the technical progress and total factor productivity growth (TFPG) of Indian manufacturing sector at regional levels. To present the discussion in lucid way, the whole paper has been divided into three broad sections. Section-I presents non-parametric Malmquist productivity index (MPI) approach to compute TFPG rates. In the Section-II, the empirical results relating with the inter-state variations in TFP growth of Indian manufacturing sector have been discussed. The final section i.e. Section-III concludes the discussion along with certain policy implications.

Section – I

This section presents the methodology relating with the computation of TFP growth rates in Indian manufacturing sector at disaggregated levels. The conventional technique for estimating TFP is Solow residual method. It defines TFP growth as the residual of output growth after the contribution of labour and capital inputs have been subtracted from total output growth. This method makes the following four assumptions:

a) The form of production function is known;
b) There are constant returns to scale;
c) There is optimizing behavior on the part of firms, with no room for any inefficiency; and
d) There is neutral technical change. If these assumptions do not hold, TFP measurement will be biased. (Coelli et. al., 1998; Arcelus and Arocena, 2000)[1]

Because of above limitations of conventional approach, in this study the estimates of TFP growth have been obtained by using non-parametric Malmquist productivity index approach developed by Fare et al. (1994). The selection of Malmquist productivity index over that of other indices of TFP is based on the fact that only the MPI

a) allows the decomposition of productivity changes into two mutually exclusive components namely technical efficiency change and technological change;
b) doesn't require price data, thereby avoiding the problems associated with unavailability or distortions of price information;
c) allows for the use of multiple inputs and for outputs without being concerned about aggregation problems; and
d) does not require a pre-specified optimizing criterion such as cost minimization or profit maximization. The main disadvantage of the MPI is the lack of a stochastic specification thus, making it insensitive to any random shocks or data measurement errors [Leung (1998)].

The Malmquist productivity index, as proposed by Caves, Christensen and Diewert(1982), is defined using distance functions, which allow one to describe multi-input, multi-output production without involving explicit price data and behavioural assumptions(such as cost minimization or profit maximization). One may define input distance function characterizes the production technology by looking at a minimal proportional contraction of the input vector, given an output vector. An output distance function considers a maximal proportional expansion of the output vector, given an input vector or purposes of this chapter, we utilize the output distance functions to calculate MPI since the manufacturing firms are more likely try to increase their outputs given their use of inputs, rather than try to decrease inputs given their outputs. Fare, Grosskopf, Norris and Zhang (1994) define an output distance function at time t as

$$D^t{}_0(x^t, y^t) = \text{nf}\{\theta \ \ (x^t, y^t / \theta \ \in S^t\} = \ \sup\{\theta \ \ )x^t, \theta \ ^t) \in S^t\})^- \qquad (1)$$

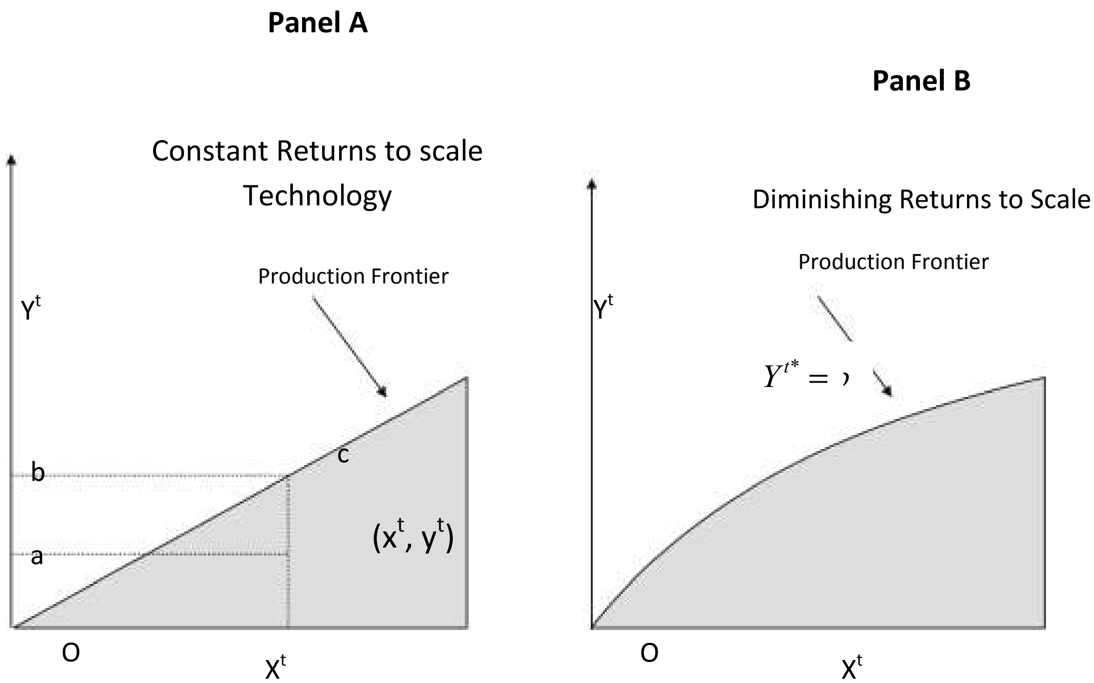
Where x^t is a vector of input quantities at time t and y^t is a vector output quantity at time t. S^t describes a production technology or production possibility set that is feasible using the technology available at time t.

The term in f{$\theta x^t, y^t / \theta\ S^t$} in equation (1) states that of the set of real numbers, θ, where θ is such that the input/output combination ($x^t, y^t / \theta$) is part of the production possibility set that is technically feasible given time t technology, we need to find the infimum or greatest lowest bound of θ. The infimum of θ is the biggest real number that is less than or equal to every number in θ. The last part of equation (1) states that finding this infimum is equivalent to finding the reciprocal of sup{θ:(x^t, θy^t)$\in$ S^t}. That is, we want to find the reciprocal of the supremum of the set of real numbers θ, where this time θ is the set of real numbers such that for a given input vector x^t the input/output combination (x^t, θy^t) is part of the production possibility set that is technically feasible given time t technology. The supremum (sup) of θ is the smallest real number that is greater than or equal to every number in θ. Figure (1) presents two possible production frontiers in the case where there is one output and one input (i.e., x^t and y^t are scalar). In panel A, the production frontier exhibits constant returns to scale. That is, if we double the level of input we double the level of output. In panel B the production frontier exhibits diminishing returns to scale implying that a doubling in the level of input results in an increase in output that is less than double. The gray shaded area (including the production frontier) on each of the two panels represents the production possibility set, given the production technology shown. It is technically feasible for the manufacturing sector to be at any point in this set, with the determining factors being the level of input available (i.e., how far to the right in figure 1 the manufacturing sector is operating at). Moreover, how efficiently the level of input is converted into output (i.e., given the level of input how close is the level of output to the production frontier) given the technology shown, it is not possible for the manufacturing sector to be operating at a point above the production frontier. The point (x^t, y^t) shown in panel A is feasible if the level of input x^t is available of production in the economy. Given that level of input, the manufacturing sector could produce anywhere along the line x^tc.

Figure 1 presents two possible production frontiers in the case where there is one input and one output (i.e., x^t and y^t are scalar). In panel A, the production frontier exhibits constant returns to scale. That is, if we double the level of input we double the level of output. In panel B the production frontier exhibits diminishing returns to scale implying that a doubling in the level of input results in an increase in output that is less than double. The grey shaded area (including the production frontier) on each of the two panels represents the production possibility set, given the production technology shown.

FIGURE 1

PRODUCTION FRONTIERS



Source: Lewin and Seiford (1997)

It is technically feasible for the manufacturing sector to be at any point in this set, with the determining factors being the level of input available (i.e., how far to the right in Figure 1 the manufacturing sector is operating at). Moreover, how efficiently the level of input is converted into output (i.e., given the level of input how close is the level of output to the production frontier) given the technology shown, it is not possible for the manufacturing sector to be operating at a point above the production frontier. The point (x^t, y^t) shown in panel A is feasible if the level of input x^t is available for production in the economy. Given that level of input, the manufacturing sector could produce anywhere along the line $x^t c$.

The term $D_o^t(x^t,y^t)$ in equation (1) is the output distance function based on the input and output vectors at time t. The subscript "o" signals that the distance function is an output distance function. The superscript "t" on the D is important as it signals which period reference technology (or production possibility frontier) the distance is being measured from.

To calculate $D_o^t(x^t,y^t)$, it is necessary to find the largest factor by which all the outputs in the output vector could be increased when making production as technically as efficient as possible, based on the input vector x^t. $D_o^t(x^t,y^t)$ is then the reciprocal of this value. The closer the manufacturing sector is to the production frontier the smaller the factor increase will be and consequently the larger the value of $D_o^t(x^t,y^t)$. if the manufacturing sector is operating on the frontier then $D_o^t(x^t,y^t)$ will take a value of 1. In contrast, when the manufacturing sector is below the frontier $D_o^t(x^t,y^t)$ will be less than 1.

In terms of figure 1(panel A), if the manufacturing sector is operating at point (x^t,y^t) then it is producing output quantity “a”. In this case, (x^t,y^t) is technically inefficient. If production were on the frontier, then the output quantity $y^* = b$ could be produced. $a\theta = b$, i.e., b is θ times as large as a. therefore $\theta = b/a$ and $D_o^t(x^t,y^t) = \theta^{-1} = a/b = y^t/y^{t*}$. Therefore, the distance function is actual output divided by the frontier level of output. Caves, Christensen and Diewert (1982a and 1982b) define the Malmquist productivity index as:

$$M^t = \frac{D^t{}_0(x^{t+}, y^{t+})}{D^t{}_0(x^t, y^t)} \qquad (2)$$

i.e., they define their productivity index as the ratio of two output distance functions, which both utilize technology at time t as a reference technology. The numerator is the output distance function at time t+1 based on period t technology. The denominator is the output distance function at time t based on period t technology. Instead of using period *t’s* technology as the reference technology it is possible to construct output distance functions based on period t+1’s technology and consequently we may construct a Malmquist productivity index as:

$$M^{t+} = \frac{D^{t+}{}_0(x^{t+}, y^{t+})}{D^{t+}{}_0(x^t, y^t)} \qquad (3)$$

Fare et al. (1994) avoid choosing an arbitrary benchmark technology by specifying their Malmquist productivity change index as the geometric mean of the indexes shown in equations (2) and (3). That is:

$$M_0(x^{t+}, y^{t+}, x^t, y^t) = \left[\left(\frac{D^t{}_0(x^{t+}, y^{t+})}{D^t{}_0(x^t, y^t)}\right)\left(\frac{D^{t+}{}_0(x^{t+}, y^{t+})}{D^{t+}{}_0(x^t, y^t)}\right)\right]^{1} \qquad (4)$$

Equation (4) can also be written as:

$$M_0(x^{t+}, y^{t+}, x^t, y^t) = \frac{D^t{}_0(x^{t+}, y^{t+})}{D^t{}_0(x^t, y^t)} \times \left[\left(\frac{D^t{}_0(x^{t+}, y^{t+})}{D^{t+}{}_0(x^{t+}, y^{t+})}\right)\left(\frac{D^t{}_0(x^t, y^t)}{D^{t+}{}_0(x^t, y^t)}\right)\right]^{1} \qquad (5)$$

Fare et al. (1994) give the following interpretation to the two terms on the right hand side of equation (5):

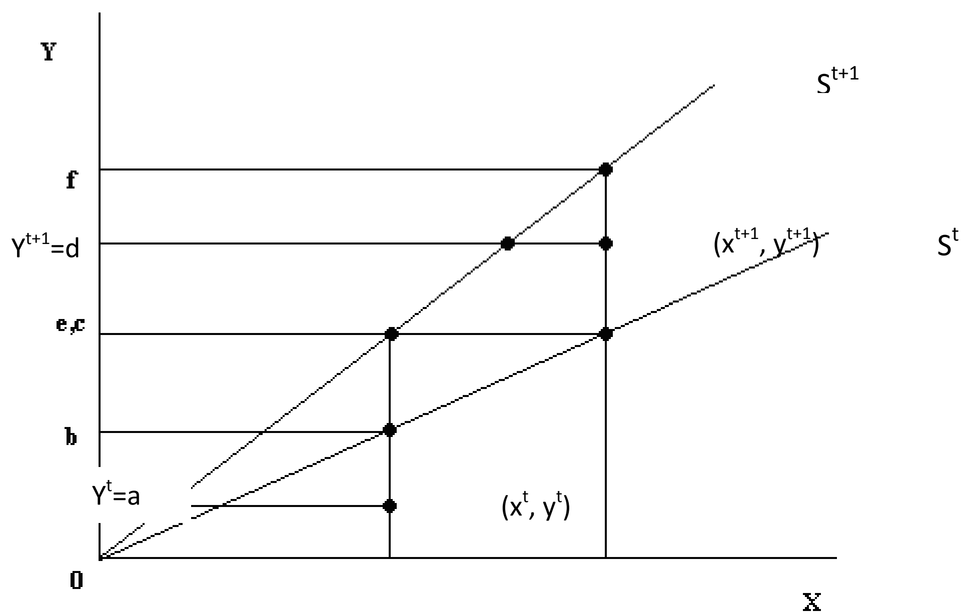
$$\text{Efficiency change} = \frac{D^t{}_0(x^{t+}, y^{t+})}{D^t{}_0(x^t, y^t)} \qquad (6)$$

$$\text{Technical change} = \left[\left(\frac{D^{t}{}_{0}(x^{t+}, y^{t+})}{D^{t+}{}_{0}(x^{t+}, y^{t+})} \right) \frac{D^{t}{}_{0}(x^{t}, y^{t})}{D^{t+}{}_{0}(x^{t}, y^{t})} \right]^{1} \quad (7)$$

Hence, the Malmquist productivity index they derive is simply the product of the change in relative efficiency that occurred between period's t and t+1, and the change in technology that occurred between periods t and t+1.

FIGURE 2

MALMQUIST PRODUCTIVITY INDEX



Source: Coelli *et al.* (2005)

Consider the following example based on figure 2, which gives the necessary pieces of information to construct a Malmquist output based productivity index. Given two constant returns to scale production frontiers (S^t and S^{t+1}) that describe the technology available in periods t and t+1 and also information on the input /output combinations that were realized by the economy during periods t and t+1. In period t, the economy used x^t input to products $y^t = a$ outputs. In period t+1 the manufacturing sector used x^{t+1} inputs to produce $y^{t+1} = d$ outputs.

To calculate the efficiency change components, we need to construct two distance functions, $D_o^{t+1}(x^{t+1},y^{t+1})$ and $D_o^t(x^t,y^t)$. These two functions tell us for each period, how close the level of output actually produced was to the frontier level of output for the same level of inputs based on the technology available in the period under consideration. These two measures describe the relative efficiency of production in each period and both will take values between 0 and 1. Based on figure 2, $D_o^t(x^t,y^t)$ =a/b as the level of output was $y^t = a$, whereas had production be technically efficient, output would have been b. $D_o^{t+1}(x^{t+1},y^{t+1}) = \frac{d}{f}$ and thus efficiency change equals $\frac{d/f}{a/b} = \frac{d}{f}\frac{b}{a}$

To calculate the technical change component we need to use the two distance functions calculated above as well as $D_o^{t}(x^{t+1},y^{t+1})$ and $D_o^{t+1}(x^{t},y^{t})$ and $D_o^{t}(x^{t+1},y^{t+1})$ measures how close the level of output actually produced in period t+1 is to the maximum level of output that could have been produced with x^{t+1} inputs had period t's technology been available. In figure 2, $D_o^{t}(x^{t+1},y^{t+1}) = \frac{d}{e}$. Note that $D_o^{t}(x^{t+1},y^{t+1})$ can exceed 1 (and does in this case) if technological advancement has occurred. $D_o^{t+1}(x^{t},y^{t})$ measures how close the level of output actually produced in period t is to be maximum level of output that could have been produced from period t's inputs, had period t+1's technology been available $D_o^{t+1}(x^{t}, y^{t}) = \frac{a}{c}$.Thus, in this example technical change equals

$$\left[\left(\frac{d/e}{d/f}\right)\left(\frac{a/b}{a/c}\right)\right]^{1} = \left[\frac{f}{e}\frac{c}{b}\right]^{1}$$

In the literature, there are different methods such as Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) that could be used to measure the Malmquist Productivity index. However, the widely used method is data envelopment analysis like linear programming method. The DEA like linear programming method can be formalized as follows.

In order to calculate the MPI for state k' between *t* and *t+1* for a constant returns-to-scale (CRS) technology, the four different distance functions that make up the index, that is, $D_o^{t}(x^{k',t}, y^{k',t}), D_o^{t+}(x^{k',t+}, y^{k',t+}), D_o^{t}(x^{k',t+}, y^{k',t+})$, and $D_o^{t+}(x^{k',t}, y^{k',t})$ are required to be calculated using linear programming approach. For calculating output-oriented distance functions for the manufacturing sector of state k', four different linear programming problems can be stated as:

$$\left.\begin{array}{ll} D_o^{t+j}(x^{k',t+j}, y^{k',t+j})^{-1} = \max \ \theta^{k'} & \\ \text{subject to} & \\ \theta^{k'} y_m^{k',t+j} \le \sum_{k=1}^{K} z^{k,t+i} y_m^{k,t+i}, & m = 1,\ldots,M; \\ \sum_{k=1}^{K} z^{k,t+i} x_n^{k,t+i} \le x_n^{k',t+j}, & n = 1,\ldots,N; \\ z^{k,t+i} \ge 0, & k = 1,\ldots,K. \end{array}\right\} \quad \textbf{(8)}$$

where (i,j)=(0,0) for solving for $(D_o^t(x^{k',t}, y^{k',t}))^-$;

(i,j)=(1,1) for solving for $(D_o^{t+}(x^{k',t+}, y^{k',t+}))^-$;

(i,j)=(0,1) for solving for $(D_o^t(x^{k',t+}, y^{k',t+}))^-$; and

(i,j)=(1,0) for solving for $(D_o^{t+}(x^{k',t}, y^{k',t}))^-$.

In the above linear programming problems, $z^{k,t}$ is an intensity variable indicating the intensity at which a particular state is employed in constructing the frontier of the technology set. The technology specified here is non-parametric but assumes constant *returns-to-scale* and strong disposability of inputs and outputs. In above formulation θ is the efficiency score and take value between 0 and 1. For non-increasing return to scale, the condition that $\sum$ is needed in (8). Following Afraid (1972), one may allow for variable returns to scale (increasing, constant or decreasing) by having $\sum$ as a restriction in all of the linear programs. Thus, estimation of distance functions defined by model along with the restriction $\sum$ enables us to decompose the *ECH* into *PECH* and *SECH* given as:

$$ECH = \underbrace{\frac{D^{t+}(\ldots^{+}, \ldots^{+})}{D_o^t(x^t, y^t / VRS)}}_{PECH} \times \underbrace{\frac{S^{t+}(\ldots^{+}, \ldots^{+})}{S_o^t(x^t, y^t)}}_{SECH} \qquad (9)$$

Section – II

This section presents an analysis of inter-temporal and interstate comparisons of TFP in the manufacturing sector of 16 states in India during the period 1979-80 to 2007-08. Beside this, an attempt has also been made to evaluate the impact of industrial reforms and deregulatory policy regime on TFP growth. This has been captured by analyzing the variation in TFP growth rates during two distinct sub periods. Following, Goldar (2004), Ray (2002) and Kumar (2003) the entire study period has been bifurcated into two distinct sub-periods: (i) Pre-Reforms Period (1979-80 to 1990-91); (ii) Post-Reforms period (1991-92 to 2007-08). The TFP growth rates for the manufacturing sector at the state and all India levels for 1979-80 to 2007-08 have been estimated from the following formula:

$$TFPG_i = \quad - \quad \times \qquad (10)$$

Where, $MALMINDEX_i$ is the Malmquist Productivity index for i^{th} state. The same procedure has been extended to compute the growth rates of component measures of Malmquist productivity index.

Table-1, 4 and 5 reports the component measures of Malmquist TFP index in entire study period (1979-80 to 2007-08), pre-reform Period (1979-80 to 1990-91) and post-reform period (1991-92 to 2007-08) respectively. From Table 1 it can be observed that TFP growth of Indian manufacturing sector of India is 9.1 percent per annum during the entire study period. Out of Sixteen Industrial states there are five states namely Uttar Pradesh, Madhya Pradesh, Gujrat , Orissa and Rajasthan where double digit TFP growth has been noticed. Manufacturing sector of Uttar Pradesh is growing with highest TFP growth at the rate of 12.8 percent per annum followed by Madhya Pradesh with TFP growth of 11.8 percent per annum. These growth rates for Gujrat, Orissa & Rajasthan are 11.7 percent, 11.2 percent and 10.8 percent respectively. Hence these five states are significantly contributing TFP growth in manufacturing sector of all India, further industrial states of Delhi, Maharashtra and Andhra Pradesh are operating with average annual growth rate of TFP above 9 percent per annum. However, another industrially developed states of West Bengal have been observed laggard of the sample with lowest TFP growth at the rate of 4.7 percent per annum.

The analysis of the sources of the TFP growth in Indian manufacturing sector reveals that both technical progress and technical change are equally contributing TFP growth in sector under evaluation. Table 2 reveals that at all India level efficiency change is greater than technical progress. Hence during the entire study period efficiency change is a major source of TFP growth. However, there are exception in which technical progress is a deriving forces of productivity improvement, these states are Bihar, Madhya Pradesh, Orissa, Rajasthan and West Bengal. In these states technology updates are at higher rate than efficiency improvement.

It is well known fact that manufacturing sector of a state is innovative in nature if it is identified technically efficient in a given year and also shifts its production frontier upward in succeeding years. Table 3 enlighten that during entire study period state of Maharashtra has been observed most innovative state. Manufacturing sector of Maharashtra has shifted its frontier upward in thirteen year out of total study period of twenty nine years. Delhi shares second rank with Maharashtra give that it has shifted production frontier 8 times. The manufacturing sector of Bihar ranked at 3rd place with five time frontier shift. Moreover in five state where dominance of technical progress has been observed. Innovations are found to be present only in two states namely Bihar and Madhya Pradesh. Even among these two states Bihar dominate Madhya Pradesh.

To analyze the impact of economic reforms on TFP growth of Indian manufacturing sector the entire study period has been bifurcated into two sub periods namely pre-reforms period (1979-80 to 1990-91) and post-reform period (1991-92 to 2007-08). Table 4 and 5 provides productivity growth summary of manufacturing sector of India at both aggregated and disaggregated levels. The comparison of productivity growth during two sub periods reveals that TFP growth in Indian manufacturing sector has fallen from 9.4 percent per annum during pre-reform period to 7.1 percent per annum during post-reform period. Hence at aggregated levels impact of economic reforms is not in a desired direction as envisaged by the policy planners of India.

However at disaggregated interstate levels an improvement has also been observed at the productivity front among different states. These states are Andhra Pradesh, Gujrat, Haryana, Punjab and West Bengal. Along with these states a mild improvement has also been observed in Kerala where TFP growth has been observed accelerated from 5.4 percent per annum during pre-reform period to 5.8 percent per annum during post-reform period. Except these six states, regress in productivity performance has been observed during post-reform period in comparison to pre-reform period.

To analyze the factors causing TFP regress among Indian states the analysis of impact of economic reforms on sources of TFP has been performed. The analysis reveals that at all India level reduction in the rate of technical progress from 6.9 percent per annum during pre-reform period to 1.8 percent per annum during post reform period, is the major factor responsible for productivity regress during the second sub period. However at efficiency front an improvement has been noticed from 2.4 percent per annum during pre-reform period to 5.2 percent per annum during the post reform period.

The interstate analysis reveals that among all the states under evaluation a regress in the growth rate of technical progress has been observed during the post reform in comparison to pre-reform period. Whereas at efficiency front except four states namely Assam, Bihar, Delhi and Orissa an efficiency improvement has been observed during the second sub period in comparison to first sub period . Even among these four states, the manufacturing sector of Orissa has witnessed mild reduction in the growth rate of efficiency from 3.2 percent per annum during pre-reform period to 3.1 percent per annum during post-reform period. Therefore at efficiency front the impact of economic reforms has been observed positive whereas at technology front an adverse impact has been noticed.

The analysis of Table 6 and Table 7 reveals that trend of source dominance has totally been reversed during the post-reform period in comparison of pre-reform period. During pre-reform period except the manufacturing sector of Delhi, technical progress dominating efficiency change among remaining fifteen major manufacturing states. Whereas during second sub period technical progress dominates only in the state of Assam, Bihar and Orissa. Except these three states observed TFP improvement is efficiency dominating during the post reform period. The direct connotation of this evidence is that despite of increasing competition due to the industrial explorer to international market learning by doing process has been strengthen. The producer is aware about the fact that production efficiency will ensure its fitness in international market and will ensure its survival in the era of liberalization, if producer will not produce efficiently, he will be thrown out of the competition. In sum efficiency game are of major concern during the reform era to be competitive in the global market.

Table 8 highlights innovative state during the pre and post-reforms periods. The number of innovative states has been doubled during the post-reform period. During pre-reform period there were only three states namely Bihar, Delhi and Maharashtra which shifted frontier outward. However during post-reform period number has been doubled and three more innovators namely Gujrat, Haryana and Madhya Pradesh accompany the aforementioned three innovators of pre-reforms period. Hence the reform process has also accelerated the innovation process which is generally efficiency oriented in nature. Therefore in general, total factor productivity growth in Indian manufacturing sector has declined after the economic reforms. At the same time, the regress in TFP during post-reform period has also been observed uneven across states.

Table 1
PRODUCTIVITY INDEX OF INDIAN MANUFACTURING SECTOR IN THE ENTIRE PERIOD
(1979-80 TO 2007-08)

States	*TCH*	ECH	Malmindex
Andhra pradesh	1.031	1.058	1.090
Assam	1.033	1.033	1.067
Bihar	1.065	1.013	1.078
Delhi	1.023	1.072	1.096
Gujarat	1.052	1.062	1.117
Haryana	1.040	1.052	1.093
Karnataka	1.030	1.055	1.086
Kerala	1.022	1.044	1.067
Maharashtra	1.040	1.051	1.092
Madhya pradesh	1.058	1.057	1.118
Orissa	1.067	1.042	1.112
Punjab	1.040	1.051	1.092
Rajsthan	1.055	1.051	1.108
Tamilnadu	1.034	1.036	1.071
Uttar Pradesh	1.047	1.077	1.128
West Bengal	1.032	1.015	1.047
All India*	1.042	1.048	1.091

Notes: i)TCH stands for technical change; ii)ECH stands for efficiency change; iii)MALMINDEX stands for Malmquist Total Factor Productivity change Index; and * refers to average of selected sixteen states.

Source: Author's Calculations.

Table 2

COMPARISON BETWEEN TECHNICAL EFFICIENCY CHANGE AND TECHNOLOGICAL CHANGE (1979-80 TO 2007-08).

States	Tech.Ch.>Effi.Ch
Andhra Pradesh	No
Assam	Equal
Bihar	Yes
Delhi	No
Gujarat	No
Haryana	No
Karnataka	No
Kerala	No
Maharashtra	No
Madhya Pradesh	Yes
Orissa	Yes
Punjab	No
Rajsthan	Yes
Tamilnadu	No
Uttar Pradesh	No
West Bengal	Yes
All India[*]	No

Notes: i)* refers to the average of sixteen major states.

Source: Author’s Calculations.

Table 3

NUMBER OF TIMES A STATE CAUSED AN OUTWARD SHIFT IN THE FRONTIER

State	Entire Period Frequency
Andhra Pradesh	00
Assam	00
Bihar	05
Delhi	08
Gujarat	02
Haryana	02
Karnataka	00
Kerala	00
Maharashtra	13
Madhya Pradesh	01
Orissa	00
Punjab	00
Rajasthan	00
Tamilnadu	00
Uttar Pradesh	00
West Bengal	00
Source : Author's Calculations.	

Table 4
PRODUCTIVITY INDEX OF INDIAN MANUFACTURING SECTOR IN THE PRE-REFORM PERIOD
(1979-80 TO 1990-91)

States	TCH	ECH	Malmindex
Andhra pradesh	1.060	1.009	1.069
Assam	1.059	1.052	1.113
Bihar	1.090	1.028	1.120
Delhi	1.051	1.074	1.128
Gujarat	1.072	1.019	1.091
Haryana	1.075	0.999	1.073
Karnataka	1.051	1.034	1.086
Kerala	1.055	0.999	1.054
Maharashtra	1.064	1.028	1.093
Madhya Pradesh	1.088	1.054	1.146
Orissa	1.088	1.032	1.122
Punjab	1.073	0.994	1.066
Rajsthan	1.090	1.010	1.100
Tamilnadu	1.060	1.006	1.066
Uttar Pradesh	1.077	1.067	1.149
West Bengal	1.056	0.971	1.025
All India*	1.069	1.024	1.094

Notes: i)TCH stands for technical change; ii)ECH stands for efficiency change; iii)MALMINDEX stands for Malmquist Total Factor Productivity change Index; and * refers to average of selected sixteen states.

Source: Author's Calculations.

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Table 5
PRODUCTIVITY INDEX OF INDIAN MANUFACTURING

SECTOR IN THE POST-REFORM PERIOD

(1991-92 TO 2007-08)

States	TCH	ECH	Malmindex
Andhra pradesh	1.006	1.081	1.087
Assam	1.009	0.995	1.004
Bihar	1.043	0.979	1.021
Delhi	0.998	1.051	1.048
Gujarat	1.035	1.081	1.118
Haryana	1.010	1.080	1.091
Karnataka	1.012	1.053	1.065
Kerala	0.994	1.065	1.058
Maharashtra	1.019	1.051	1.070
Madhya Pradesh	1.032	1.072	1.106
Orissa	1.048	1.031	1.080
Punjab	1.010	1.083	1.094
Rajsthan	1.024	1.068	1.093
Tamilnadu	1.012	1.041	1.053
Uttar Pradesh	1.021	1.067	1.107
West Bengal	1.011	1.034	1.045
All India*	1.018	1.052	1.071

Notes: i)TCH stands for technical change; ii)ECH stands for efficiency change; iii)MALMINDEX stands for Malmquist Total Factor Productivity change Index; and * refers to average of selected sixteen states.

Source: Author's Calculations.

Table 6

COMPARISON BETWEEN TECHNICAL EFFICIENCY CHANGE AND TECHNOLOGICAL CHANGE IN PRE-REFORMS PERIOD

(1979-80 TO 1990-91).

States	Tech.Ch.>Effi.Ch
Andhra Pradesh	Yes
Assam	Yes
Bihar	Yes
Delhi	No
Gujarat	Yes
Haryana	Yes
Karnataka	Yes
Kerala	Yes
Maharashtra	Yes
Madhya Pradesh	Yes
Orissa	Yes
Punjab	Yes
Rajsthan	Yes
Tamilnadu	Yes
Uttar Pradesh	Yes
West Bengal	Yes
All India*	Yes

Notes: * refers to the average of sixteen major states.

Source: Author's Calculations.

Table 7

COMPARISON BETWEEN TECHNICAL EFFICIENCY CHANGE AND TECHNOLOGICAL CHANGE IN POST REFORM PERIOD

(1991-92 TO 2007-08).

States	Tech.Ch.>Effi.Ch
Andhra Pradesh	No
Assam	Yes
Bihar	Yes
Delhi	No
Gujarat	No
Haryana	No
Karnataka	No
Kerala	No
Maharashtra	No
Madhya Pradesh	No
Orissa	Yes
Punjab	No
Rajsthan	No
Tamilnadu	No
Uttar Pradesh	No
West Bengal	No
All India*	No

Notes: * refers to the average of sixteen major states.

Source: Author's Calculations.

Table 8

NUMBER OF TIMES A STATE CAUSED AN OUTWARD SHIFT IN THE FRONTIER

State	Pre-Reform Frequency	Post-Reform Frequency
Andhra Pradesh	00	00
Assam	00	00
Bihar	03	02
Delhi	02	06
Gujarat	00	02
Haryana	00	02
Karnataka	00	00
Kerala	00	00
Maharashtra	08	05
Madhya Pradesh	00	01
Orissa	00	00
Punjab	00	00
Rajasthan	00	00
Tamilnadu	00	00
Uttar Pradesh	00	00
West Bengal	00	00

Source : Author's Calculations.

Section – III

To check the growth robustness of Indian manufacturing sector total factor productivity growth have been analysed. The Malmquist productivity index (MPI) has been used to analyze TFP growth. The use of MPI has been preferred over traditional non-frontier techniques given the property of MPI that it decomposes the TFP into two mutually exclusive and non-additive components namely, efficiency change (indicator of catching-up) and technological change (indicator of shift in production function). However, the non-frontier techniques assume that all firms are different and thus, TFP is the outcome of frontier shift or technological change only.

The present paper endeavors to analyze the TFP growth trends in Indian manufacturing sector at both aggregated and disaggregated inter-state levels. Using the Malmquist productivity index for panel dataset of 16 major industrial state over a period of 29 years spanning over 1979-80 to 2007-08, the study observed manufacturing sector of India is growing with 9.1 percent per annum growth of Total Factor Productivity (TFP) during the entire study period. Out of Sixteen Industrial states there are five states namely Uttar Pradesh, Madhya Pradesh, Gujarat, Orissa and Rajasthan where double digit TFP growth has been noticed. The manufacturing sector of Uttar Pradesh is growing with highest TFP growth at the rate of 12.8 percent per annum followed by Madhya Pradesh with TFP growth of 11.8 percent per annum. The analysis of the sources of the TFP growth in Indian manufacturing sector reveals that both technical progress and technical change are equally contributing TFP growth in sector under evaluation. It has also been observed that at all India level efficiency change is greater than technical progress.

The analysis of the impact of economic reforms on TFP growth of Indian manufacturing sector reveals that TFP growth in Indian manufacturing sector has fallen from 9.4 percent per annum during pre reform period to 7.1 percent per annum during post reform period. Hence at aggregated levels impact of economic reforms is not in a desired direction as envisaged by the policy planners of India. However at disaggregated interstate levels the analysis rectifies that except six states, a regress in productivity performance has been observed during post-reforms period in comparison to pre-reform period.

To analyze the factors causing TFP regress among Indian states and analysis of impact of economic reforms on sources of TFP has been performed. The analysis reveals that at all India level reduction in the rate of technical progress from 6.9 percent per annum during pre-reform period to 1.8 percent per annum during post reform period, is the major factor responsible for productivity regress during the second sub period. However at efficiency front an improvement has been noticed from 2.4 percent per annum during pre-reform period to 5.2 percent per annum during the post reform period. The interstate analysis reveals that among all the states under evaluation a regress in the growth rate of technical progress is a major source of sluggishness in productivity performance during the post-reforms period in comparison to the pre-reforms period.

Productivity growth is one of the major determents of competitiveness and profitability and profitability of a firm. A higher level of productivity may result in lower product price, better remunerations and working conditions for the employees, better return to investors and adequate surplus to the firms for plant expansion and modernization. India adopted reform programmes to augment the efficiency and productivity of Indian manufacturing sector, so as to make the Indian firms more competitive in international market.

The results shows that the overall manufacturing sector grew at 9.4 percent in the pre-reform period and in all the States technical progress grew at the faster rate than the technical efficiency. But in post reform period, the average rate of productivity growth has declined to 7.1 percent. At the aggregate level, there was an improvement in the technical efficiency after the reforms as compared with pre-reform period. The TFP growth in Indian manufacturing decelerated in the post-reform period. Since there was a spurt in investment activity in the 1990s in response to economic reforms, there was possibly an immediate adverse effect on the productivity due to gestation lags. Another possible line of argument is that there was considerable potential for productivity improvement in the beginning of 1980s, and this potential was used to attain a rapid growth in productivity. And as this source of productivity enhancement got increasingly exhausted, it became difficult to maintain a rapid growth in productivity in the 1990s.

The total factor productivity for the entire study period showed that the Manufacturing industry grew significantly at the rate of 9.1 percent. It has been observed that the rate of total factor productivity in the post-reform period at the aggregate level and also most of the states under the study has noticed a decline in total factor productivity growth in the post-reform period. Therefore, after the reforms, the Indian manufacturing sector showed a decline in TFP growth both at aggregated as well as disaggregated level. Further, the decomposition analysis with the help of Malmquist productivity index revealsed that in almost all the States technical change is less than efficiency change. On the other hand in the post-reform period growth in technical change declined whereas of efficiency change improved as compared to pre-reform period. In this context, it can be concluded that productivity growth in Indian manufacturing sector can be improved by technical change, thereby implies the improvement in the technique of production through innovations or by technological adoptions among firms. Thus, the policy framework needs to encourage R&D activity geared to build-in-house capability for product and process innovations for competing industries in the increasingly globalised and knowledge-based world economy.

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